

two (? or three) pairs of thin dental plates in the upper jaw, the hinder pair attenuated mesially and not closely apposed in the median line; lower dentition consisting of a pair of large dental plates, meeting at the symphysis, and a median incisor-like tooth in front. A few dermal plates present upon the head; males with a large prehensile spine upon the snout.

XXXVII.—*Sketch of the History of known Fossil Sponges in Relation to those of the Present Day.* By H. J. CARTER, F.R.S. &c.

IN this brief "Sketch" I propose to state my impressions as to the relation the species of fossil sponges that have been found bear to those which now exist, since in going over the former I have been forcibly struck with the total absence of any certain representatives of the horny sponges, whose toughness and durability combined with their great abundance would lead one to infer that at least they would be as likely to be handed down through fossilization as the elytra of insects.

To give an idea of the abundance of existing horny sponges and their accumulation in certain localities favourable to future fossilization I may mention, first, that at the beginning of 1845, when I was attached as Medical Officer to the Survey of the South-east Coast of Arabia, I saw on the low sandy coast close to Ras Abu Ashrin, opposite the north-east end of the Island of Masira (where there is a little "bite" which receives the backwater of the current produced by the waves of the south-west monsoon as they rush by it to the mainland during this tempestuous season), a raised ridge, about 50 yards from the margin of the sea (then calm), covered, as I thought, with bushy plants, but which on examination proved to be large Keratophytes, horny sponges, and a host of other *eauvia* mixed up with sand, all of which had drifted into this position (the result probably of many of the monsoons when the sea reached this ridge). Secondly, that Dr. R. v. Lendenfeld, in his "Monograph on the Australian Sponges" (Proc. Linn. Soc. N. S. Wales, vol. ix. pt. ii. p. 311), has stated that the horny sponge *Aplysilla violacea*, L., "covers many thousand metres in Port Phillip," and that of the 348 horny sponges from all parts of the world, which he has enumerated in his Monograph, 258 or 74·1 per cent. "occur in the Australian seas"

(p. 822). And, thirdly, that the quantity of the horny-fibred sponges, particularly from the sea on the south coast of Australia and that about the West-India Islands, in the collection at the British Museum, far surpasses all the rest in bulk and number of species.

Here I must, for the sake of convenient reference, insert a note of my Classification of 1875 ('Annals,' vol. xvi. p. 128 &c.) :—

Class SPONGIDA, Huxley.

Order I. *Carnosa*.

Without evident skeleton.

Order II. *Ceratina*.

Possessing a skeleton composed of horny (now called "spongin") fibre, with a granular, chiefly hollow, core, containing for the most part no foreign bodies.

Order III. *Psammonemata*.

Possessing a skeleton composed of solid fibre more or less cored with foreign bodies (grains of sand, fragments of sponge-spicules, &c.).

Order IV. *Rhaphidonemata*.

Possessing a skeleton composed of horny fibre with a core of "proper spicules" (that is, spicules produced by the sponge itself). Spicules chiefly simple acerate, and chiefly confined to the *interior* of the fibre.

Order V. *Echinonemata*.

Possessing a skeleton composed of horny fibre cored with "proper spicules" internally and echinated with "proper spicules" externally. Form of spicule chiefly acuate.

Order VI. *Holorhaphidota*.

Possessing a skeleton whose fibre is almost entirely composed of "proper spicules" bound together with a minimum of sarcode (spongin). Form of spicule variable.

Order VII. *Hexactinellida*.

Possessing a skeleton charged with "proper spicules," all

based upon a sexradiate type, coring vitreous fibre or held together by spongin only.

Order VIII. Calcarea.

Possessing calcareous spicules only.

Now with reference to the first order, which I divided into Halisarcida (possessing no spicules) and Gumminida (possessing spicules), it could hardly be expected that the first division would be perpetuated in a fossilized state, or if so not recognizably, seeing that in the fresh state they are of gelatinous softness and their sponge nature can only be determined by the microscope before they pass into decomposition (which is very rapid), or when kept under the influence of a preservative fluid.

But this does not apply to the second division, where, to the "gelatinous softness," perhaps a little inspissated, is added an abundance of spicules which more or less resemble those of other sponges, especially some of the HOLO-RHAPHIDOTA in my sixth order. Thus we find *Chondrilla phyllodes*, Sdt., possessing a spiculation that hardly differs from that of *Spirastrella cunctatrix*, Sdt., which is a member of my family Suberitida (see also my assimilation of *Suberites domuncula*, Sdt., to *Chondrosia reniformis* in my order CARNOSA, 'Annals,' 1881, vol. viii. p. 255). One could hardly expect under fossilization either one or the other species to present more than a heap of spicules of the same kind, with perhaps a trace of the canal-structure. But who has found "either one or the other," or how could they be distinguished?

When we consider that the spiculiferous CARNOSA may in a fossilized state be hardly more than an almost shapeless mass of the same form of spicules, it reminds me of my *Holasterella conferta* from the Carboniferous Limestone near Glasgow ('Annals,' 1879, vol. iii. p. 141, pl. xxi. figs. 1-8), in which the spicules appear to me to come nearest to those of Schmidt's Adriatic species *Corticium candelabrum* (Spong. Adriat. Meeres, p. 42, Taf. iii. fig. 25); but some of the Suberitida might, if fossilized, present a heap of similarly shaped spicules to those of *Corticium abyssii* ('Annals,' 1873, vol. xii. p. 18, pl. i. figs. 1-9 and 15); and *Corticium Kittoni* (*ib.* 1874, vol. xiv. p. 24, pl. xv. figs. 48 a, b, c) may be equally confounded with the tetrahedral form of a Lithistid, to which perhaps may be added Schulze's *Pla-*

kina (Zeitschrift f. wiss. Zool. 1880, Bd. xxxiv. Taf. xx.-xxii.).

Next come the CERATINA (Order II.), which, with the exception of the following order, viz. PSAMMONEMATA, appear to be by far the most abundant of all existing sponges, and at the same time may reach a very large size (*ex. gr.* the *Luffaria* from the West-Indian seas, in the British Museum), whose kerataceous fibre is so thick and hard when dry that it breaks with the shining fracture of hard glue.

This horn-like substance, which, as before stated, has lately received the name of "spongin," is in its elementary composition so nearly allied to the chitin of the insect-skeleton that it seems strange that the latter should be handed down in a fossilized state (if such should be the case) and not the former.

According to Krukenberg the elementary composition of spongin and chitin respectively is as follows:—

Spongin.....	C. 30	H. 46	N. 9	O. 13
Chitin	15	26	2	10

Thus (to me) the former is the densest and physically the most solid of the two, especially in *Luffaria*.

What the branched forms in the Quadersandstein of Saxony, called by their discoverer Geinitz "*Spongites saxonicus*," or the net-like figuration on the surface of crooked cylindrical bodies ("*Rhizocorallium*," alluded to by Zittel, 'Handbuch der Palæontologie,' pp. 142, 143), may be remains to be decided.

Again, there is no mention of the PSAMMONEMATA (Order III.) in a fossilized state, although I found them in a recent one in such great abundance in the "ridge" on the south-east coast of Arabia above alluded to—seeming to indicate in this instance the first step towards fossilization, if not also what would probably have taken place and been recognized in former fossilizations if such had occurred.

My *Dysidia antiqua* from the Carboniferous of Ayrshire ('Annals,' 1878, vol. i. p. 139) has been relegated by Dr. Hinde to those kinds of sponges which come under my order HOLORHAPHIDOTA, by the generic name of "*Hapliston*" (Mon. Brit. Spong. Palæontographical Society's vol. for 1887, pt. ii. p. 147, pt. i. pl. v. figs. 2, 2 a).

Of the RHAPHIDONEMATA, whose fibre is again corneous, I found a small branched fragment, apparently of a *Chalina*, having the usual form of acerate spicule presented by that family, in a detrital piece of chert from the remains of the Upper Greensand so abundant in this locality (Budleigh

Salterton, Devon); but beyond this nothing identifiable with the sponge-structure of this family.

Nor have I ever found any remains of the (equally corneous) ECHINONEMATA, in which the echinated fibre, if well preserved, could hardly pass unrecognized. That of *Dirrhopalum* (*Plocamia*), to which Dr. Hinde has alluded in his Monactinellidæ (Cat. Foss. Spong. Brit. Mus. p. 20), and which I had placed in my order ECHINONEMATA, requires further investigation, as Dr. Hinde himself has intimated, before this can be confirmed.

But when we come to my HOLORHAPHIDOTA (Order VI.) we *do* see that accumulations of Monaxonid spicules have been found heaped together as well as in separate spicules—e. g. *Pulvillus Thomsoni*, Crtr., from the Carboniferous of Dumfries in Scotland ('Annals,' 1878, vol. i. p. 137, pl. x. figs. 1-6), also *Rhaphidhistia vermiculata*, Crtr., from the Carboniferous of Ayrshire (*ib. ib.* p. 140), which has been described by Dr. Hinde under the name of "*Hapliston vermiculatum*" (Palæont. Society's Publ. vol. for 1887, *l. c.*), *Climacospongia radiata*, Hinde (Cat. Foss. Spong. Brit. Mus. p. 18, pl. i. figs. 1, 1 a), *Lasiocladia compressa* (*ib.* p. 19, pl. i. fig. 2), and *Acanthorhaphis intertextus* (*ib.* p. 20, pl. i. figs. 3, 3 a); to which may be added Zittel's two species of his *Scoliorhaphis* from the Upper Cretaceous of North Germany (Foss. Sponges, Abhandl. der k. bayer. Akad. d. Wiss. ii. C. xiii. Bd. ii. pp. 94, 95, Taf. xii. figs. 1 a, b, and 2).

The layer of pin-like spicules discovered by Dr. Harvey B. Holl on the surface of the Calcsponge *Verticillites helvetica*, de L. ('Annals,' 1884, vol. xiv. p. 27, pl. i. figs. 6-10), appears to me to have consisted of those of a parasitic species of Suberite, of which there are many existing instances on other sponges. The boring sponge, *Cliona*, whose existing species are chiefly characterized by a pin-like spicule, has also been recognized in several cases more by the peculiar form of its excavations in fossilized casts than by that of the spicule, which has not been described if ever seen.

We next come to the third and fourth families of my HOLORHAPHIDOTA, viz. the Pachytragida and Pachastrellida, now called "Tetractinellida," of which the only *entire* specimen among the three groups of the former that has been described is that of a *Stelletta*, viz. *S. inclusa*, Hinde, which, as it occurs in the interior of a flint, is easily recognized by being *unaccompanied* by the coating of siliceous spheroids which chiefly separates that genus from *Geodia* (Cat. Foss. Spong. Brit. Mus. p. 24, pl. i. figs. 6, 6 a); while in the first division of the latter, viz. the Pachastrellina (group 17), four specimens have been described,

viz. *Pachastrella primæva*, *Tethyopsis Steinmanni*, *P. convoluta*, and *P. plana*—the former two by Zittel (Foss. Spong. l. c. p. 100, Taf. xi. figs. 3 and 4) and the latter two by Dr. Hinde (Cat. Foss. Spong. Brit. Mus. p. 26, pl. ii. figs. 1, 1 *a*, and pl. i. figs. 7, 7 *a* respectively).

This brings us to the other division of the Pachastrellida, viz. the Lithistina, which in time and space so far surpasses any other group of sponges, extending from the Silurian—*Aulocopium*, *A. aurantium*, Zitt. (*op. cit.* p. 136, pl. viii. fig. 1, and 'Handbuch,' pp. 159, 160, fig. 72 *a*) ; also *Hindia*, Hinde, *H. fibrosa* (Cat. Foss. Sp. Brit. Mus. p. 57, pl. xiii., and for spiculation, 'Annals,' 1887, vol. xix. p. 76, figs. 1 and 2)—down to the present day inclusively, but abounding most in the Oolitic and Cretaceous periods, as may be seen by reference to the table in Prof. Zittel's 'Study on Fossil Sponges,' more particularly given in his illustrated descriptions (Abhandl. der k. bayer. Akad. der W. ii. Cl. xiii. Bd. i. Abth. pp. 67 &c. ; translated into the 'Annals' by W. S. Dallas, F.L.S., in 1878, vol. ii. pp. 113, 235, 324, 385, and 467 respectively), wherein an amount of sagacity and ability is exhibited that is almost beyond all praise.

Happening to reside in a locality (viz. Budleigh Salterton, on the south coast of Devon) where the hardened remains of the Upper Greensand and Chalk, which once extended across the country for many miles between "Haldon Hill" on the west and "High Peak Hill" on the east, now bestrew the surface in great abundance, I can state from actual observation that almost every chert-flint contains the remains of a Lithistid sponge or consists of chertified Lithistid spicules &c. in layers which once formed the bed of an ocean, so abundant were these sponges at that period.

Thus it would appear that the maximum development of Lithistid sponges took place during the Upper Cretaceous period, although the existing species are still very numerous.

Among the separate spicules which are so abundant in the Upper-Greensand chert may also be seen those of many other sponges, especially those of *Geodina*, whose little siliceous spheroids seem to be always present in great numbers. In the Upper Greensand of "Haldon Hill," near Exeter, where there is a bed several feet in thickness composed of grains of sand and sponge-spicules, these ingredients are so loosely held together that the latter can be easily picked out, as may be seen by my illustrated paper on the subject in the 'Annals' of 1871 (vol. vii. p. 112, pls. vii., viii., ix., and x.).

That many originally came from the spiculiferous sponges of my Orders IV., V., and VI. generally, may be fairly

assumed; but in no instance, except the end of a branch of a *Chalina* mentioned, have I been able to find the spicule *in situ*, that is in the entire structure of which it formed part, and this *only* conjecturally.

I also noticed the occurrence of sponge-spicules from the Carboniferous strata of Ben Bulbin in the north of Ireland, near Sligo, wherein the chert appears to be composed of them in a transitionary state from the entire spicule to a homogeneous mass; also in the Carboniferous of Scotland near Glasgow ('Annals,' 1880, vol. vi. p. 209, pl. xiv. B. figs. 1-17); but the latter case has been much more elaborately dealt with by Dr. Hinde in his paper on the "Organic Origin of the Chert" ('Geological Magazine,' dec. iii. vol. iv. no. 10, p. 435, October 1887), where, at p. 442, he observes that in thin slices of this chert and that from other localities examined with the microscope by transmitted light, "it is resolved into microscopic spicules, confusedly intermingled together, whose individual outlines can be traced with varying degrees of clearness."

Hence the chert in the Carboniferous period appears to indicate a similar condition to that in which it is found in the Upper-Greensand detritus at this place (Budleigh Salterton), and in the spiculiferous sand-bed at "Haldon Hill" to which I have alluded.

Among the fossil spicules which I have figured (*l. c.*) are undoubted forms that originally came from the Monaxonid group, *ex. gr.* the bihamate, Bk. (sigma, R. & D.), no. 43 (*l. c.*), which, although it can be seen with the naked eye, being 1-400th inch in length, is exceeded by the largest existing form that I have observed, viz. in *Esperia villosa*, where it is fully 1-64th of an inch (Journ. Roy. Mic. Soc. 1879, vol. ii. pl. xvii *a.* fig. 12 *b.*). But while recent specimens of the bihamate exceed in length the fossil one that I have mentioned, the largest of several tricurvates (toxa, R. & D.) that I have just found among other sponge-spicules, chiefly Tetractinellid, in a transparent portion of Upper-Greensand chert from this locality, measures from 1-16th to 1-7th inch in length, the largest recent specimen that I have seen, viz. that which I described and figured in 1874 ('Annals,' vol. xiv. p. 457, pl. i. fig. 27), being only 1-60th inch long, although in other respects, that is in the straightness and length of the arms, relative smallness and abruptness of the bow, together with its semicircular form, it closely resembles the fossil; moreover, the arms appear to have been spined for two thirds of their length. Of the longest specimen only about three fourths remain, so that the measurement from

the unbroken end to the centre of the bow *doubled* has to be taken for the total length, which is 1-7th inch, as above mentioned, while that of the other largest specimen, which is perfect, is 1-16th in. There are several specimens in the piece of chert mentioned which are very near together, and being close to the surface of the fractured portion of the chert are satisfactorily seen, while the bow in some of the smaller ones appears to be higher and wider, *i. e.* more like that of *Microciona armata*.

Doubtless hereafter there will be more fossilized spicules found which can be identified with those of recent Monaxonida; but at present they are all confined to what I have delineated, with the exception of the tricurvates just mentioned and what have been added by Prof. Zittel and Dr. Hinde in their works respectively, viz. those by the former in the Abhandl. der k. bayer. Akad. der W. ii. Cl. xii. Bd. iii. Abth. Taf. iii.-vii., and those by the latter in his Mon. Brit. Foss. Sponges (Palæont. Soc. Publ. vol. for 1886, pt. i. p. 66).

We now come to my seventh order, viz. the HEXACTINELLIDA, which, from Salter's *Protospongia fenestrata* in the Cambrian, have been continued down to the present day, manifesting themselves plentifully in a Hyalonematoid form from the Carboniferous Limestone of Ayrshire, viz. *Hyalonema Smithii* ('Annals,' 1878, vol. i. p. 129, pl. ix. figs. 1-14), subsequently called "*Hyalostelia*" by Zittel (Hinde, Cat. Foss. Spong. Brit. Mus. p. 150, pl. xxxii. figs. 1, 1 g). But it is not until the Cretaceous period is reached that the vitreous Hexactinellida or so-called "Glassy Sponges" appear to have come into prominence, and here their maximum of development, like that of the Lithistida, seems to have taken place, as may be seen by a reference to Zittel's illustrated description of this order (Abhandl. der k. bayer. Akad. der W. ii. Cl. xiii. Bd. i. of 1877, translated by Mr. Dallas into the 'Annals' of that year, vol. xx. pp. 237, 405, and 501; also Dr. Hinde's illustrated description of the Fossil Sponges in the British Museum, p. 91 &c.).

Among the detritus of the Upper Greensand in this locality to which I have alluded, the remains of the Hexactinellida that I have found are very scarce, in comparison with those of the Lithistida, so that we may fairly infer that the former were not so plentiful as the latter, as shown by Zittel's splendid researches (*l. c.*). While at the present day they appear to bear a similar proportion, so far as my observations extend, which would have been more complete had I been able to refer

to a copy of Prof. Schulze's Report on the 'Challenger' dredgings of the Hexactinellida.

Lastly, we come to my eighth order, viz. the CALCAREA; and here, again, we have to fall back upon the masterly researches of Professor Zittel, coupled with those of his intelligent pupil Dr. G. J. Hinde—the former to be found in the *Abhandl. der bayer. Akad. W. ii. Cl. xiii. Bd. ii. Abth.*, and the latter in Dr. Hinde's 'Catalogue of the Fossil Sponges in the British Museum,' p. 157 &c. Referring to Prof. Zittel's observations on the "Occurrence, Distribution in Time, and Pedigree" of the Calcispongiæ (translation 'Annals,' 1879, vol. iii. pp. 375–378), we learn, from the tabular view given at p. 378, that, so far as is known, they at least date from the Devonian period, are already numerous in the Triassic, increase rapidly in the Jurassic, and culminate like the Lithistida in the Cretaceous, after which isolated spicules only have been found.

At first (like all who attempt to generalize from insufficient data) I was inclined to think, from the small delicate forms and rapidly decomposing nature of the British species, that it was impossible they could be subjected to the ordeal of fossilization without disappearing altogether; and if this had been the case generally I might have been right; but when I found that Prof. Zittel had demonstrated the reverse, by proving to me, from actual slices of what he considered to be fossil calcareous sponges, that they possessed the peculiar radiate spicules of a Calcisponge, and when, from the characters of the South-Australian sponges of the present day which Mr. Bracebridge Wilson, of Geelong, kindly sent me ('Annals,' 1886, vols. xvii. and xviii. p. 503 &c.), I could acquiesce in this from recent specimens, the absurd notion inferred from the characters of the British representatives of this order could no longer be entertained. Meanwhile several specimens from the Coral Rag (Jurassic system) of Farringdon, in Berkshire, from which I made as many microscopically thin slices, fully justified Prof. Zittel's announcement.

Furthermore, Dr. Hinde, in his "Notes on Fossil Calcispongiæ" ('Annals,' 1882, vol. x. p. 185, pls. ix. and x.), describes not only specimens of his *Verticillites d'Orbigny* from the Greensand at Warminster, in which the radiate spicules could be seen with a simple lens in abundance on the surface, but a new species of *Sestrostomella* from the Upper Greensand of "Vaches Noires," near Havre, in France (*S. rugosa*, H.), in which he found the "tuning-fork"-like form of spicule that characterizes a recent species which Mr. Bracebridge Wilson

sent me from the neighbourhood of Port Phillip on the south coast of Australia, first represented by Dr. Bowerbank (B. S. vol. i. fig. 237) and subsequently called "*Lelapia australis*" by Dr. Gray (Proc. Zool. Soc. 1867, p. 557). I have said "species" because the upper part of the specimens which Mr. Bracebridge Wilson sent me ('Annals,' 1886, vol. xviii. p. 148) bore a close resemblance to the heads of *Sestrostomella* represented by Dr. Hinde, as well as to those of a fossil group from the Jura which Prof. Zittel kindly sent me, in which, in microscopic slices, I also found the form of spicule mentioned; all of which demonstrates the accuracy of Prof. Zittel's observations.

I wish also to note here that, although I have considered Dr. Sollas's "*Pharetrospongia Strahani*" (Quart. Journ. Geol. Soc. May 1877, p. 242), from which Professor Zittel has taken the name of his third family of this order, viz. "Pharetrones," among his Calcispongiæ ('Handbuch,' p. 189), to be a siliceous sponge like an Australian species of *Reniera* (Monaxonina) whose spicule Dr. Sollas has introduced among his illustrations for comparison (*op. et loc. cit.* pl. xi. figs. 11 and 12), yet from subsequent facts which have come to my knowledge,—such as the existence of a Calcisponge with the same kind of fusiform, sharp-pointed, acerate spicule, viz. *Leucyssa spongilla*, Hæck. ('Die Kalkschwämme,' Bd. ii. p. 137, Atlas, Taf. xxv. figs. 11–13), evidently designated after the characteristic spicule of *Spongilla* (although it should be also stated that the spicule of *Leucyssa spongilla* is not curved as in *Spongilla* and *Pharetrospongia Strahani*, &c., but straight, still it is the only form of spicule in this sponge),—together with the statements of Dr. Hinde (Cat. Foss. Sp. B. M. pp. 202, 203) in support of Prof. Zittel's view that *Pharetrospongia Strahani* was a Calcisponge, I must now yield to their opinion, who for a while made the study of fossil sponges their special object.

Thus, in conclusion, I have given a short sketch of the known history of sponges in time and space from the earliest geological periods up to the present day, among which we notice the absence of any fossil representative of the Horny Sponges, which are now so abundant and whose fibre in many instances (ex. gr. *Luffaria*) is almost entirely composed of spongin, which, in elementary composition, as shown in the first part of this paper, only differs from chitin (the elytra of insects) in quantity, while the quality of resistance would appear to be in favour of the former; and yet fossilized insects have been handed down to us in almost every geolo-

gical period from the Upper Silurian strata to the Miocene inclusively.

Whether this non-existence of the Horny Sponges must be left for further investigation to verify or whether it can be explained by deferred development, that is to the present era, or in any other way, I will not go further here than the fact that the Horny Sponges are by far the most abundant at the present day and yet have no fossil representative.

XXXVIII.—*On the possible Origin of the Malpighian Tubules in the Arthropoda.* By FRANK E. BEDDARD, M.A., F.Z.S.

THERE are two sets of structures in the Arthropoda which have been proved to possess a renal function and which have been regarded as possibly equivalent to the nephridia of worms.

The "green glands" of the Crustacea are commonly regarded as nephridia, and researches now in progress will, I believe, establish the nephridial nature of these organs upon a very firm basis of fact.

Among the Arthropoda another class of renal organs exists in the so-called Malpighian cæca. These occur in a few Crustacea, *e. g.* the Amphipoda (Spencer, "The Urinary Organs of the Amphipoda," Quart. Journ. Micr. Sci. xxv. 1885), and in Tracheata; in the latter group they consist of a variable number of glandular cæca which grow out from the proctodæum; in the Amphipoda, on the contrary, Spencer finds reasons for believing that the tubes in question are diverticula of the mesenteron.

The only known Arthropod with unmistakable nephridia, paired and metamerically arranged, is *Peripatus*. The existence of these organs was originally pointed out by Balfour ("On some Points in the Anatomy of *Peripatus capensis*," Quart. Journ. Micr. Sci. xx. 1880), and has been since carefully studied from the developmental as well as from the structural point of view by Sedgwick ("A Monograph of the Development of *Peripatus capensis*," Stud. Morph. Lab. Cambridge, vol. iv. pt. i.). Lankester had previously pointed out that the "coxal glands" of *Limulus* were in all probability to be regarded as modified nephridia, and this position is strongly supported by Sedgwick's results. So far as our present knowledge goes it may be safely assumed that the